Eastern Research Group, Inc.

AREA SOURCE ASPHALT PAVING PROJECT

Final

Prepared for:

Ms. Paige Sprague
Texas Commission on Environmental Quality
Air Quality Division
Building E, Room 336S
Austin, TX 78711-3087

June 23, 2017

ERG No. 0345.00.011.007
TCEQ Contract No. 582-15-50416
Work Order No. 582-17-71651-11

AREA SOURCE ASPHALT PAVING PROJECT

Final

Prepared for:

Ms. Paige Sprague
Texas Commission on Environmental Quality
Air Quality Division
Building E, Room 336S
Austin, TX 78711-3087

Prepared by:

Eastern Research Group, Inc.
8950 Cal Center Drive, Suite 230
Sacramento, CA 95826

June 23, 2017

TABLE OF CONTENTS

Section **Page**

Tables **Page**

ACRONYMS

CERS	Consolidated Emissions Reporting Schema
EIIP	Emission Inventory Improvement Program
ERG	Eastern Research Group, Inc.
H_2S	hydrogen sulfide
HAP	hazardous air pollutant
lbs	pounds
MSDS	material safety data sheet
NAAQS	National Ambient Air Quality Standard
NAPA	National Asphalt Pavement Association
NEI	National Emissions Inventory
OSD	ozone season daily
PAH	polycyclic aromatic hydrocarbon
SCC	Source Classification Code
SIC	Standard Industrial Code
SIP	State Implementation Plan
TCEQ	Texas Commission on Environmental Quality
TexAER	Texas Air Emissions Repository
tpy	tons per year
TxAPA	Texas Asphalt Pavement Association
TxDOT	Texas Department of Transportation
U.S. EPA	U.S. Environmental Protection Agency
VMT	vehicle miles traveled
VOC	volatile organic compound
XML	Extensible Markup Language

ES.0 EXECUTIVE SUMMARY

Eastern Research Group, Inc. (ERG) developed an updated 2014 area source inventory of total volatile organic compound (VOC) and other applicable hazardous air pollutant (HAP) emissions for cutback and emulsified asphalt paving activities associated with Source Classification Codes (SCCs) 2461021000 and 2461022000 in the state of Texas. ERG developed Texas-specific VOC and other applicable HAP emission factors for cutback and emulsified asphalt paving activities.

ERG, with the assistance of the Texas Asphalt Pavement Association (TxAPA), initially conducted a survey of liquid asphalt suppliers and contractors in Texas to develop updated emission factors. Survey respondents were asked to provide chemical composition data for cutback and emulsified asphalt paving activities in Texas. The survey did not produce a viable response rate, largely due to respondents' confidentiality concerns.

ERG developed and implemented an alternative approach to determine the chemical composition of cutback and emulsified asphalt under the direction of the TCEQ. ERG compiled a list of liquid asphalt producers in the state of Texas using available data from the TxAPA. ERG then conducted online searches of these companies' material safety data sheets (MSDS) for cutback and emulsified asphalt products. In certain cases, producers were contacted via phone and email to obtain MSDS. This information was used to develop updated Texas-specific VOC and other applicable HAP emission factors for cutback and emulsified asphalt paving activities.

The state-wide asphalt usage was obtained from the U.S. EPA's 2014 Emulsified Asphalt Paving and Cutback Asphalt Paving Tools. The state-wide asphalt usage was then allocated to individual counties based on 2014 asphalt consumption data from Texas Department of Transportation (TxDOT) projects and county-level vehicle miles traveled (VMT) data from TxDOT.

A summary of estimated VOC emissions is provided in Table ES-1.

Table ES-1. Overall 2014 Emissions Inventory for Texas

SCC	SCC Description	VOC (tpy)
2461021000	Solvent Utilization Miscellaneous Non-industrial: Commercial Cutback Asphalt Total: All Solvent Types	3,613.5
2461022000	Solvent Utilization Miscellaneous Non-industrial: Commercial Emulsified Asphalt Total: All Solvent Types	17,381.1

For comparison purposes, the original 2014 NEI estimates for these SCCs are presented in Table ES-2 along with the updated estimates developed by ERG.

Table ES-2. Comparison of 2014 NEI and ERG Developed VOC Estimates for Cutback and Emulsified Asphalt Paving

Emission Source	ERG VOC (tpy)	2014 NEI VOC (tpy)
Cutback Asphalt	3,613.5	5,949.2
Emulsified Asphalt	17,381.1	15,114.2
Total VOC	20,994.6	21,063.4

Examination of the methodologies used in the 2014 NEI (i.e., data and methods used to update the VOC emission factors) indicates that the NEI VOC emission factors were based on a very limited number of MSDS that were compiled via online search. ERG developed updated emission factors using data from all cutback and emulsified asphalt paving product producers located in Texas.

As can be seen from Table ES-2, the ERG results indicate a reduction in cutback asphalt emissions and an increase in emulsified asphalt emissions compared with the original 2014 NEI estimates. This also reflects the current market trends where emulsified asphalt is much more widely used than cutback asphalt.

1.0 INTRODUCTION

Eastern Research Group, Inc. (ERG) was contracted by the Texas Commission on Environmental Quality (TCEQ) to develop Texas-specific emission factors for cutback and emulsified asphalt paving activities associated with SCCs 2461021000 and 2461022000.

ERG contacted TxAPA for their assistance in conducting an email survey of their members. TxAPA members include all the liquid asphalt producers and numerous contractors involved in asphalt paving operations in Texas. ERG, in consultation with TxAPA, conducted a data collection survey via email. The survey response was very low and no data were compiled through the survey. ERG, in consultation with the TCEQ, developed and implemented an alternate method to develop VOC and HAP emission factors.

The emission factors were developed using chemical composition data obtained from asphalt manufacturers' MSDS. The updated emission factors, asphalt usage from the U.S. EPA's 2014 Emulsified Asphalt Paving and Cutback Asphalt Paving Tools, and TxDOT 2014 asphalt consumption data and county-level VMT data were used to develop a 2014 area source cutback and emulsified asphalt paving emissions inventory for Texas (U.S. EPA, 2016a). The updated 2014 asphalt paving emissions inventory includes annual and ozone season daily emissions for all 254 Texas counties for all applicable VOC and HAPs. An Asphalt Paving Calculator containing the updated emissions factors was also developed to allow for future estimation of emissions from asphalt paving activities; the final version was submitted separately to the TCEQ.

This report describes the steps taken to develop Texas-specific VOC and HAPs emission factors for cutback and emulsified asphalt paving activities and associated emissions inventory for the State of Texas in the following sections:

- Section 2.0 describes the data collection survey and includes a brief description of the survey population and results;
- Section 3.0 describes the development of Texas-specific emission factors for VOC and HAPs;
- Section 4.0 provides a description of the emission inventory development including the emission estimation method and activity data;
- Section 5.0 summarizes results and the asphalt paving emissions calculator;

- Section 6.0 lists all references used in the development of the emission factors, emissions inventory, and associated report; and
- Appendix A includes the survey questionnaire emailed to liquid asphalt suppliers and contractors in Texas.

2.0 DATA COLLECTION SURVEY

To determine the appropriate survey coverage necessary to develop robust emission factors and activity, ERG conducted initial research focused on the following areas:

- Previous studies conducted by the U.S. Environmental Protection Agency (U.S. EPA);
- TCEQ regulatory databases (e.g., Fees Database and Central Registry); and
- Key industry and trade organizations (e.g., National Asphalt Pavement Association [NAPA], Texas Asphalt Pavement Association [TxAPA])

ERG's initial research findings are described below:

- ERG's review of previous U.S. EPA studies focused on studies conducted over the last 15 years. Specifically, ERG's starting point for review was the asphalt paving document from the Emission Inventory Improvement Program (EIIP) (EIIP, 2001). The endpoint of the review was the asphalt paving documentation for Version 1 of the 2014 National Emissions Inventory (NEI) developed by U.S. EPA (U.S. EPA, 2016b). EIIP recommended emission factors were used in the 2008 NEI and 2011 NEI to estimate VOC emissions from cutback asphalt and emulsified asphalt paving operations. For the 2014 NEI, U.S. EPA updated the cutback and emulsified asphalt paving VOC emission factors. This update was based on asphalt composition data obtained from Material Safety Data Sheets (MSDS) identified through online searches. Apart from these two sources, ERG was not able to identify any additional U.S. EPA studies on cutback and emulsified asphalt paving emissions.
- An extract of information from the TCEQ Central Registry was provided by TCEQ staff for Standard Industrial Classification (SIC) code 2951 (Asphalt Paving Mixtures and Blocks). A total of 185 facilities were contained in this extract and were identified as asphalt batch plants, paving contractors, construction companies, and material suppliers (e.g., asphalt, aggregates, quarries). This dataset also contained multiple locations for some companies. There were approximately 63 unique companies in the dataset obtained from TCEQ. The data obtained from the TCEQ consisted primarily of account number, company name, county, and SIC. The data did not contain contact information for the listed businesses/facilities. This dataset contains information on all types of asphalt producers (i.e., hot mix asphalt, cutback asphalt, and emulsions). Based on the available data fields, ERG identified 37 facilities (out of 185) that are potential hot mix asphalt plants. There was insufficient information to identify the type of asphalt produced for the reminder of the facilities.

Also, the lack of contact information in this dataset made it unsuitable to develop the survey population. Due to these reasons, ERG relied on industry trade organization(s) to identify and develop the survey population.

- Several industry and trade organizations were examined, but the most appropriate asphalt-related industry or trade organization was the Texas Asphalt Pavement Association (TxAPA). ERG contacted Harold Mullen (TxAPA Executive Vice President) to obtain TxAPA support for this project. Both the TxAPA Executive Committee and Environmental Committee indicated that this project was of interest to their organization and that they were willing to assist in the collection of Texas-specific data from their members.

ERG reviewed TxAPA's on-line membership directory (TxAPA, 2017a). The membership directory includes four types of entities: contractors, liquid asphalt suppliers, other suppliers, and testing labs. A brief description of these entities is provided below.

- **Liquid asphalt suppliers –** businesses primarily engaged in the manufacture of liquid asphalt to sell to asphalt suppliers who in turn produce their own asphalt cement/concrete; asphalt liquid suppliers also include refineries.

- **Suppliers –** businesses that manufacture or supply asphalt cement/concrete, as well as paving equipment, transportation services, insurance and bonding services, legal services, construction aggregate, and other ancillary services.

- **Contractors –** paving and construction contractors and asphalt producers that manufacture asphalt cement/concrete in enough volume for their own contracts, as well as to sell to other contractors that do not own asphalt batch plants.

- **Testing labs –** laboratories that typically test asphalt physical properties (but not chemical properties.

Based on recommendations from TxAPA staff, it was determined that the appropriate survey population would include all Texas-based liquid asphalt suppliers (53) and contractors (62) in TxAPA's membership.

ERG prepared two separate surveys: a higher priority survey for the liquid asphalt suppliers and a lower priority survey for the contractors. These surveys were designed to capture chemical composition data (i.e., ingredients and weight %) for cutback and emulsified asphalt products. These surveys were reviewed by both the TxAPA Executive Committee and the TxAPA Environmental Committee prior to dissemination to TxAPA membership. A cover letter was also prepared on TxAPA letterhead. TxAPA distributed the surveys via email to their

membership on March 24, 2017 with a requested response data of April 7, 2017. Both surveys are included in Appendix A.

Although TxAPA participation was expected to significantly increase the survey response rate, the actual response rate was extremely low (consisting of three liquid asphalt suppliers and one contractor). The only responses were from companies that: 1) indicated that they only produced or used hot mix asphalt or other asphalt-related products; and 2) that they did not produce or use cutback or emulsified asphalt. Several of the larger liquid asphalt suppliers either indicated that as company policy that they do not respond to surveys or that a confidentiality agreement would be needed for possible participation. TxAPA provided some additional follow-up to their membership but this did not produce any additional results. Since there were only four survey responses, ERG, in consultation with TCEQ staff, decided to implement an alternative method to develop Texas-specific VOC and HAP emission factors.

ERG's proposed alternative method was to conduct targeted online research to identify and obtain MSDS for cutback and emulsified asphalt products for the liquid asphalt suppliers located in Texas and members of TxAPA. The results of the online research are documented in Section 3.0.

3.0 EMISSION FACTOR DEVELOPMENT

ERG reviewed TxAPA's online membership list and identified 16 liquid asphalt suppliers that are located in Texas. This list includes major producers such as Valero, Ergon, Martin Asphalt, Western Emulsions, and Shell. ERG performed an online search to compile MSDS for cutback and emulsified asphalt products produced by these suppliers. In some cases (i.e., MSDS only available upon request or producer does not have a website), ERG contacted the producers to request MSDS for relevant cutback and emulsified asphalt products.

A summary of ERG's online search findings for the 16 liquid asphalt suppliers is shown below:

- Seven liquid asphalt suppliers have publicly available MSDS for cutback or emulsified asphalt (Alon Asphalt Company, Blacklidge Emulsions, Ergon Asphalt & Emulsions, Heartland Asphalt Materials, Martin Asphalt Company, Valero, and Wester Emulsions). A total of 51 MSDS (17 for cutback asphalt and 34 for emulsified asphalt) were obtained from these suppliers.
- Four liquid asphalt suppliers do not produce cutback or emulsified asphalt (Gulf Coast Asphalt, Owens Corning, Shell Oil Products US, and Wright Asphalt Company).
- Five liquid asphalt suppliers do not have readily available MSDS for cutback or emulsified asphalt (Calumet Specialty Products Partners, Cleveland Asphalt Products, Jebro, Lion Oil Company, and Rooker Asphalt Company). ERG contacted these suppliers via telephone, but did not receive any data.

Based on the chemical composition data that were available from the compiled MSDS, ERG developed Texas-specific representative profiles for cutback and emulsified asphalt. In most cases, the chemical composition data were indicated as ranges (e.g., diluent – 10-40 percent [by weight]). ERG assumed that the midpoint of the range was a representative value for the indicated chemical component. All available data were aggregated for each component (or group of components) and the average value was developed for the representative profile.

For cutback asphalt, the following list of components was identified during the review of the compiled MSDS:

- Diluents – diesel, petroleum distillates (heavy and light), gas oil, kerosene, light cycle oil, mineral spirits, naphtha, No 1. fuel and No 2. fuel;
- Benzene;
- Toluene;
- Ethylbenzene;
- Xylene;
- Hydrogen sulfide (H_2S);
- Polycyclic aromatic hydrocarbons (PAHs);
- Naphthalene; and
- Other – additives, vulcanizing agent, anti-strip agent, polymer modifier, and alkanes (heptane, hexane, nonane, octane, etc.).

The "other" category and H_2S were excluded from the VOC emission factor calculations as these components are assumed to have no VOC content. ERG took the average value (VOC weight percent) for each of these component categories to develop a Texas-specific model profile for cutback asphalt, shown in Table 3-1.

Table 3-1. Texas-Specific Model Profile for Cutback Asphalt

Component	Average Weight %	Notes
Diluent	22.79	
Naphthalene	0.83	Includes 0.1 PAH
Benzene	0.24	
Toluene	0.65	
Ethylbenzene	0.67	
Xylene	0.83	
H_2S	0.31	No VOC content
Other	1.11	No VOC content

For emulsified asphalt, the following list of components were identified during the review of the compiled MSDS:

- Diluents – diesel, heavy naphthenic distillate solvent, kerosene, naphtha, petroleum distillates, and proprietary diluents;
- Elastomers – polymers/latex, polymer modifiers, proprietary polymer, styrene-butadiene copolymer, and styrene butadiene latex;
- Emulsifiers and surfactants;

- H_2S;
- PAHs; and
- Other – additives, thickeners, stabilizers, vulcanizing agents, anti-strip agents, and proprietary components.

Elastomers, emulsifiers and surfactants, H_2S, and the "other" category components were excluded from VOC emission factor calculations as these ingredients were assumed to have no VOC content. ERG took the average value (VOC weight percent) for each of these ingredient categories to develop a Texas-specific model profile for emulsified asphalt, shown in Table 3-2.

Table 3-2. Texas-Specific Model Profile for Emulsified Asphalt

Component	Average Weight %	Notes
Diluent	11.73	
Emulsifiers	3.1	No VOC content
Elastomers	5.5	No VOC content
PAH	0.1	
H_2S	0.4	No VOC content
Other	1.75	No VOC content

Using the cutback and emulsified asphalt profiles presented in Tables 3-1 and 3-2, ERG calculated Texas-specific emission factors for VOC and HAPs assuming 95 percent of all VOC is emitted, as was done in the 2014 NEI (U.S. EPA, 2016a). These emission factors are presented in Table 3-3.

Table 3-3. Texas-Specific Cutback and Emulsified Asphalt Emission Factors

Asphalt Type	Pollutant	Emission Factor (lb/ton asphalt)
Cutback	VOC	494.40
	Naphthalene	15.83
	Benzene	4.54
	Toluene	12.42
	Ethylbenzene	12.73
	Xylene	15.83
	H_2S	5.97
Emulsified	VOC	224.83
	H_2S	7.60

Example calculations showing the emission factor development for cutback asphalt are as follows:

Step 1: Calculate emission factors for individual HAPs.

$$Naphthalene = \left(\frac{0.83}{100}\right) \times 2000 \times 0.95 = 15.83 \frac{lb}{ton}$$

$$Benzene = \left(\frac{0.24}{100}\right) \times 2000 \times 0.95 = 4.54 \frac{lb}{ton}$$

$$Toluene = \left(\frac{0.65}{100}\right) \times 2000 \times 0.95 = 12.42 \frac{lb}{ton}$$

$$Ethylbenzene = \left(\frac{0.67}{100}\right) \times 2000 \times 0.95 = 12.73 \frac{lb}{ton}$$

$$Xylene = \left(\frac{0.83}{100}\right) \times 2000 \times 0.95 = 15.83 \frac{lb}{ton}$$

$$H_2S = \left(\frac{0.31}{100}\right) \times 2000 \times 0.95 = 5.97 \frac{lb}{ton}$$

Step 2: Calculate VOC emission factor by adding all the above HAPs and diluent, except H_2S.

$$Diluent = \left(\frac{22.79}{100}\right) \times 2000 \times 0.95 = 433.04 \frac{lb}{ton}$$

$$VOC = (15.83 + 4.54 + 12.42 + 12.73 + 15.83 + 5.97) + 433.04 = 494.40 \frac{lb}{ton}$$

4.0 ASPHALT EMISSIONS INVENTORY DEVELOPMENT

In the 2014 Cutback Asphalt Paving and Emulsified Asphalt Paving Tools, U.S. EPA developed county-specific paved road utilization fractions to allocate 2014 state-level asphalt paving usage for cutback and for emulsified asphalt to various counties. This method focuses on the quantity of travel on paved roads, allocating asphalt paving activity to areas with the highest travel (i.e., areas with high VMT). U.S. EPA's activity data allocation method divides VMT by paved lane-miles to develop the paved road utilization measure. The Emission Inventory Improvement Program (EIIP) guidance document recommends using VMT as a preferred method for spatial allocation of activity data or emissions data for paving operations rather than lane-miles or population (EIIP, 2001). Due to the specificity of TxDOT data to the inventory domain and the inventory year (i.e., asphalt usage for 2014, and county-level VMT for 2014), ERG developed a new allocation method rather than use U.S. EPA's allocation method as used in the 2014 NEI.

ERG used a top-down approach to allocate 2014 U.S. EPA state-level asphalt paving usage for cutback and for emulsified asphalt to the county-level. The 2014 U.S. EPA state-level asphalt usage (i.e., cutback and emulsified asphalt quantities for Texas) was obtained from the U.S. EPA's 2014 Emulsified Asphalt Paving and Cutback Asphalt Paving Tools (U.S. EPA, 2016a). The asphalt usage data used in these tools originates from the Asphalt Institute for 2008. Due to unavailability of recent asphalt consumption data, these state-level asphalt usage data for cutback and emulsified asphalt were used without adjustment.

The first step to apportioning the 2014 EPA state-level asphalt paving usage to Texas counties was to create TxDOT district-level allocation factors. ERG obtained Texas-specific data on TxDOT 2014 county-level asphalt usage for state emulsified and cutback asphalt projects (TxDOT, 2017). TxAPA and TxDOT both estimated that TxDOT projects account for approximately half (i.e., 50 percent) of all annual cutback and emulsified asphalt usage in the state (TxDOT, 2017; TxAPA, 2017b). TxDOT 2014 county-level asphalt usage for both cutback and emulsified was summed to each of the respective 25 TxDOT district-levels. ERG then calculated district allocation factors for each TxDOT district by dividing the TxDOT district-level cutback and emulsified asphalt quantities by the TxDOT state-level cutback and emulsified totals.

The second step to apportioning the 2014 U.S. EPA state-level asphalt paving usage to Texas counties was to create county-level allocation factors. County allocation factors were developed by dividing county-level VMT by the TxDOT district-level VMT. County-level VMT estimates for 2014 were obtained from the *Roadway Inventory Annual Reports* published by TxDOT (TxDOT, 2014).

The U.S. EPA state-level asphalt paving usage for both cutback and emulsified asphalt at the county-level was then determined. The 2014 U.S. EPA state-level asphalt usage for cutback and for emulsified asphalt was apportioned to the district-level using TxDOT district-level allocation factors. Then the district-level asphalt paving usage was apportioned to the county-level using the TxDOT county-level allocation factors.

VOC and HAP emissions were then estimated using county-level cutback and emulsified asphalt quantities and the Texas-specific emissions factors. The example calculation below shows the allocation of state-level activity data to Harris County. Harris County is located within the Houston TxDOT District (District ID 12).

Step 1: Aggregate asphalt quantities used for TxDOT projects within the Houston District.

$$Houston\ District_{Cutback} = \sum_{Cutback} (Brazoria, Fort\ Bend, Galveston, Harris, Montgomery, Waller)$$

$$Houston\ District_{Cutback} = (0\ gal + 0\ gal + 0\ gal + 0\ gal + 14{,}688\ gal + 99{,}774\ gal) = 114{,}462\ gallons$$

Step 2: Develop TxDOT District Allocation Factor by dividing Houston District asphalt total with the state-level asphalt total from TxDOT data.

$$Houston\ District_{DAF} = \frac{Houston\ District_{Cutback}}{Texas_{Cutback}} = \frac{114{,}462\ gallons}{9{,}173{,}034\ gallons} = 0.01248$$

Step 3: Develop County Allocation Factor for Harris County by dividing Harris County VMT by Houston District VMT total.

$$Houston\ District_{VMT} = \sum_{VMT} (Brazoria, Fort\ Bend, Galveston, Harris, Montgomery, Waller)$$

$$Houston\ District_{VMT} = (5{,}713{,}600.7 + 8{,}937{,}920.6 + 5{,}474{,}925.4 + 92{,}494{,}833.9 + 11{,}428{,}075.1 + 1{,}909{,}805.7) = 125{,}959{,}161.4 \text{ miles}$$

$$Harris\ County_{CAF} = \frac{Harris\ County_{VMT}}{Houston\ District_{VMT}} = \frac{92{,}494{,}833.9}{125{,}959{,}161.4} = 0.734$$

Step 4: Estimate Harris County cutback asphalt usage by multiplying the state-level cutback asphalt quantity (from 2014 NEI) with Houston District Allocation Factor and Harris County Allocation Factor.

$$Harris\ County_{Activity-Cutback} = Texas_{Activity-Cutback} \times Houston\ District_{DAF} \times Harris\ County_{CAF}$$

$$Harris\ County_{Activity-Cutback} = 14{,}618\ tons \times 0.01248 \times 0.734 = 133.9\ tons$$

5.0 RESULTS

The results of the 2014 Texas area source asphalt emissions inventory are presented in Table 5-1 below.

Table 5-1. 2014 Texas Asphalt Emissions Inventory Summary

SCC	Description	Pollutant	Emissions (TPY)
2461021000	Asphalt Paving Operations - Cutback Asphalt	VOC	3,613.5
		Naphthalene	115.7
		Benzene	33.2
		Toluene	90.8
		Ethylbenzene	93.0
		Xylene	115.7
		H_2S	43.6
2461022000	Asphalt Paving Operations - Emulsified Asphalt	VOC	17,381.1
		H_2S	587.5
Total		**VOC**	**20,994.6**

The activity data used to estimate emissions were obtained from U.S. EPA's 2014 Cutback Asphalt Paving and Emulsified Asphalt Paving Tools at the state-level. The emission factors that were used were the newly developed Texas-specific VOC and applicable HAP emission factors.

The cutback and emulsified asphalt quantities allocated to counties by using ERG's method and U.S. EPA's method (in the 2014 NEI) were significantly different. As explained in Section 4.0, above, U.S. EPA's method relied on VMT data and paved road lengths and so counties such as Bexar, Dallas, and Harris were allocated the highest asphalt quantities for both cutback and emulsified asphalt paving operations. Whereas, ERG's allocation method largely relied on actual quantities of cutback and emulsified asphalt used for TxDOT projects in 2014, and so Bexar, Dallas, and Harris counties were not allocated high asphalt quantities. This allocation scheme is in line with Texas rules associated with controlling emissions of VOCs from cutback and emulsified asphalt that are part of the State Implementation Plan (SIP) strategy to meet the National Ambient Air Quality Standard (NAAQS) for ozone (Title 30, Texas Administrative Code, Chapter 115, Subchapter F, Division 1, §115.510 through §115.519). These rules are in effect in various areas in Texas identified in the SIP (i.e., Houston-Galveston-Brazoria, Dallas-Fort Worth, Beaumont-Port Arthur, El Paso, Austin-Round Rock, and Corpus

Christi). The Texas rules have control requirements for cutback and emulsified asphalt paving activities in these identified SIP areas. These control requirements either prohibit the use and sale of cutback asphalt during ozone season months (April through September) or limit the VOC content in both cutback and emulsified asphalt paving products. TxDOT data is in line with these regulatory requirements and so ERG's activity data allocation method tends to allocate lower cutback and emulsified asphalt quantities to counties in identified SIP areas, compared to U.S EPA's allocation method employed in the 2014 NEI.

The U.S. EPA developed emission factors for cutback and emulsified asphalt paving activities based on chemical composition data obtained from MSDS for various cutback and emulsified asphalt products. The U.S. EPA's documentation indicates that a total of 8 MSDS were identified and compiled (U.S. EPA, 2016a).

- Cutback (4 total) – (all Rapid Cure)
  - Asphalt Emulsion Industries
  - Martin Asphalt Company
  - Mohawk Asphalt Emulsions
  - Valero
- Emulsified (4 total)
  - Asphalt Emulsion Industries
  - Marathon (2)
  - U.S. Oil & Refining Company

ERG identified and compiled 51 MSDS sheets from 16 liquid asphalt producers in Texas. There were 17 cutback asphalt MSDS (representing all cutback grades) and 34 MSDS for emulsified asphalt produced in Texas. The VOC emission factor developed for cutback asphalt using the chemical composition data compiled by ERG was much lower than the original 2014 NEI emission factor, whereas the emulsified VOC emission factors were similar. Table 5-2 shows the 2014 NEI emission factors and the Texas-specific emission factors developed for the TCEQ.

Table 5-2. Comparison of VOC Emission Factors From 2014 NEI and TCEQ Area Source Asphalt Paving Project

Source	Pollutant	Texas-Specific Emission Factors (lb/ton asphalt)	2014 NEI Emission Factors (lb/ton asphalt)
Cutback Asphalt	VOC	494.40	813.96
	Naphthalene	15.83	11.02
	Benzene	4.54	3.61
	Toluene	12.42	11.21
	Ethylbenzene	12.73	9.31
	Xylene	15.83	18.81
	H_2S	5.97	1.71
Emulsified Asphalt	VOC	224.83	195.51
	Naphthalene	No Data	5.51
	H_2S	7.60	1.71

Once the annual inventory was developed, ERG assumed equal activity distribution to estimate ozone season day (OSD) emissions. ERG divided the annual emissions by 365 days to develop the OSD emissions in units of pounds (lbs) per day.

ERG also developed an Asphalt Paving Calculator as part of this project. The Asphalt Paving Calculator contains the required data and calculations used to develop the area source cutback and emulsified asphalt emission inventory: the Texas-specific VOC and HAP emission factors, the 2014 TxDOT data used to develop district and county allocation factors, the activity data allocation scheme (from state-level to counties), TxDOT district to Texas counties mapping scheme, and the emission calculations and tables. This Asphalt Paving Calculator was developed for the purpose of updating the area source asphalt inventory for future years using the same estimation methodology. The Asphalt Paving Calculator also has instructions on how the user can update the inventory for future years based on updated activitry data.

ERG converted the emissions file and associated data developed for this project into the Consolidated Emissions Reporting Schema (CERS) Extensible Markup Language (XML) suitable for importing of emissions data into Texas Air Emissions Repository (TexAER). ERG quality assured the data based upon the TexAER loading requirements. All CERS files were completed with all mandatory fields validated. Emissions data could not be quality assured using the U.S. EPA's Critical Emissions Range Check, because the area source asphalt SCCs

(2461021000 and 2461022000) are not included. All resulting TexAER loadable files for the 2014 periodic inventory were successfully entered into TexAER.

6.0 REFERENCES

EIIP, 2001. *Asphalt Paving – Area Source and Area Source Method Abstracts*, Volume III, Chapter 17, Revised Final. Emission Inventory Improvement Program (EIIP), Area Sources Committee. January. Internet address: https://www.epa.gov/sites/production/files/2015-08/documents/ iii17_apr2001.pdf

ERG, 2017. "Final Data Collection Plan", Technical Memorandum prepared for Texas Commission on Environmental Quality (TCEQ) by Eastern Research Group, Inc. (ERG), Sacramento, CA. February 24.

TxAPA, 2017a. Texas Apshalt Pavement Association's Online Member Directory. Accessed in February 2017. Internet Address: http://www.texasasphalt.org/af_memberdirectory.asp

TxAPA, 2017b. Telephone conversation between Karen Pagitt (TxAPA) and Marty Wolf (ERG). May 26.

TxDOT, 2014. *Roadway Inventory Annual Reports, 2014*. Texas Department of Transportation. Internet address: http://www.txdot.gov/inside-txdot/division/transportation-planning/roadway-inventory.html

TxDOT, 2017. 2014 TxDOT project asphalt usage by county provided via email by Jerry Peterson (TxDOT). April 28.

U.S. EPA, 2016a. 2*014 National Emissions Inventory, Version 1*. U.S. Environmental Protection Agency. December. Internet address: https://www.epa.gov/air-emissions-inventories/2014-national-emissions-inventory-nei-data

U.S. EPA, 2016b. Nonpoint Source Category – Asphalt Paving – Proposed Update of EPA Emission Estimation Method for 2014 NEI. U.S. Environmental Protection Agency (U.S. EPA). December 23. FTP address: ftp://ftp.epa.gov/EmisInventory/2014/doc/nonpoint

APPENDIX A

Liquid Asphalt Suppliers and Contractors Survey

TXAPA
Dedicated to Quality

Harold C. Mullen
Executive Vice President

March 17, 2017

Texas Asphalt Pavement Association Member
Re: TCEQ/ERG Asphalt Survey

Dear Member:

The TXAPA is currently coordinating with Eastern Research Group, Inc. (ERG) to conduct an asphalt chemical composition survey for the Texas Commission on Environmental Quality (TCEQ). The TCEQ has contracted with ERG in an effort to improve upon the emission estimation methodology for cutback and emulsified asphalt application used by the U.S. Environmental Protection Agency (U.S. EPA) in the development of the draft 2014 National Emissions Inventory (NEI).

Both the TXAPA Executive Committee and the TXAPA Environmental Committee believe that this is an important and worthwhile effort. In particular, our industry can provide Texas-specific information that will improve the quality of the emission estimates in the final 2014 NEI.

This survey is only focused on cutback and emulsified asphalt; hot mix asphalt is not the focus of this survey. There are two versions of the survey: a more detailed survey for liquid asphalt suppliers and a simpler survey for contractors and suppliers.

All survey information supplied to ERG will remain confidential. Specific chemical composition data will not be linked to individual members. Chemical composition data will only be presented as an average or range of values. Due to project deadlines, we are asking members to respond to the survey by April 7, 2017.

Any questions can be directed to either me or Marty Wolf at ERG (916-635-6594 [work], 916-540-9236 [cell], or marty.wolf@erg.com).

All data can be submitted to ERG by email (gopi.manne@erg.com) or by mail (8950 Cal Center Drive, Suite 230, Sacramento CA 95826).

Sincerely,

Harold C. Mullen

Harold Mullen
TXAPA Executive Vice President

PO Box 1468 ♦ Buda, Texas 78610 ♦ Phone: (512) 312-2099 ♦ Fax: (512) 312-5043

Texas Asphalt Survey Data Collection Form – Liquid Asphalt Suppliers

1. What is the primary business of your establishment?

   _____

2. Does your establishment/business **produce** liquid asphalt (cutback or emulsified) for use in Texas paving operations? (YES/NO): _____

3. If YES for Question 2, for **each** individual cutback or emulsified product produced, please fill out the product chemical composition in Table A (cutback) or Table B (emulsified). Copy table multiple times as needed. Provide MSDS or other chemical composition documentation (chemical laboratory analyses, etc.), if available.

4. Comments?

   _____
   _____
   _____
   _____
   _____

Submit data to ERG:

Email – gopi.manne@erg.com
Mail – 8950 Cal Center Drive, Suite 230, Sacramento CA 95826

1

Table A. Cutback Asphalt Chemical Composition

Cutback Asphalt Product Name			
Chemical Composition	**Avg % by Weight**	**Density (lbs/gal)**	**Notes**
Asphalt			
Gasoline			
Naphtha			
Kerosene			
Diesel			
Other Solvent (specify_____)			
Naphthalene			
Toluene			
Xylenes			
Benzene			
Ethylbenzene			
Polycyclic Aromatic Hydrocarbons (PAHs)			
Hydrogen Sulfide			
Other (specify_____)			
Other (specify_____)			
Proprietary Components			
Usage Limitations (describe in space provided)			
In what areas of Texas (TxDOT regions, nonattainment areas, urban vs. rural, etc.) is this product banned, limited, or not recommended?			
Is this product marketed/used outside of Texas? If YES, please indicate location.			
For what months of the year is application of this product not recommended?			
For what conditions (temperature, humidity, etc.) is application of this product not recommended?			
For what paving applications is this product not recommended?			

Table B. Emulsified Asphalt Chemical Composition

Emulsified Asphalt Product Name			
Chemical Composition	**Avg % by Weight**	**Density (lbs/gal)**	**Notes**
Asphalt			
Gasoline			
Naphtha			
Kerosene			
Diesel			
Other Solvent (specify_____)			
Naphthalene			
Polycyclic Aromatic Hydrocarbons (PAHs)			
Sulfur Compounds			
Emulsifier			
Polymer Modifier			
Water			
Other (specify_____)			
Other (specify_____)			
Proprietary Components			
Usage Limitations (describe in space provided)			
In what areas of Texas (TxDOT regions, nonattainment areas, urban vs. rural, etc.) is this product banned, limited, or not recommended?			
Is this product marketed/used outside of Texas? If YES, please indicate location.			
For what months of the year is application of this product not recommended?			
For what conditions (temperature, humidity, etc.) is application of this product not recommended?			
For what paving applications is this product not recommended?			

TXAPA
Dedicated to Quality

Harold C. Mullen
Executive Vice President

March 17, 2017

Texas Asphalt Pavement Association Member
Re: TCEQ/ERG Asphalt Survey

Dear Member:

The TXAPA is currently coordinating with Eastern Research Group, Inc. (ERG) to conduct an asphalt chemical composition survey for the Texas Commission on Environmental Quality (TCEQ). The TCEQ has contracted with ERG in an effort to improve upon the emission estimation methodology for cutback and emulsified asphalt application used by the U.S. Environmental Protection Agency (U.S. EPA) in the development of the draft 2014 National Emissions Inventory (NEI).

Both the TXAPA Executive Committee and the TXAPA Environmental Committee believe that this is an important and worthwhile effort. In particular, our industry can provide Texas-specific information that will improve the quality of the emission estimates in the final 2014 NEI.

This survey is only focused on cutback and emulsified asphalt; hot mix asphalt is not the focus of this survey. There are two versions of the survey: a more detailed survey for liquid asphalt suppliers and a simpler survey for contractors and suppliers.

All survey information supplied to ERG will remain confidential. Specific chemical composition data will not be linked to individual members. Chemical composition data will only be presented as an average or range of values. Due to project deadlines, we are asking members to respond to the survey by April 7, 2017.

Any questions can be directed to either me or Marty Wolf at ERG (916-635-6594 [work], 916-540-9236 [cell], or marty.wolf@erg.com).

All data can be submitted to ERG by email (gopi.manne@erg.com) or by mail (8950 Cal Center Drive, Suite 230, Sacramento CA 95826).

Sincerely,

Harold C. Mullen

Harold Mullen
TXAPA Executive Vice President

PO Box 1468 ♦ Buda, Texas 78610 ♦ Phone: (512) 312-2099 ♦ Fax: (512) 312-5043

TXAPA
Dedicated to Quality

Texas Asphalt Survey Data Collection Form – Contractors/Suppliers

1. What is the primary business of your establishment?
   _____

2. Does your establishment/business **use** liquid asphalt (cutback or emulsified) for paving operations in Texas? (YES/NO): _____

3. If YES for Question 2, for **each** individual cutback or emulsified product used, please provide the appropriate MSDS.

4. If YES for Question 2, please estimate the percentage of your annual paving work that is done during the months of June, July, and August: _____

5. If YES for Question 2, please identify where your paving work is performed. Indicate either TxDOT region or specific counties.
   _____
   _____
   _____
   _____
   _____

6. Comments?
   _____
   _____
   _____
   _____
   _____

Submit data to ERG:

Email – gopi.manne@erg.com
Mail – 8950 Cal Center Drive, Suite 230, Sacramento CA 95826

1